INVESTIGATION OF NUCLEAR STRUCTURE OF ^{110}Cd AND ^{76}Se NUCLEI

THESIS

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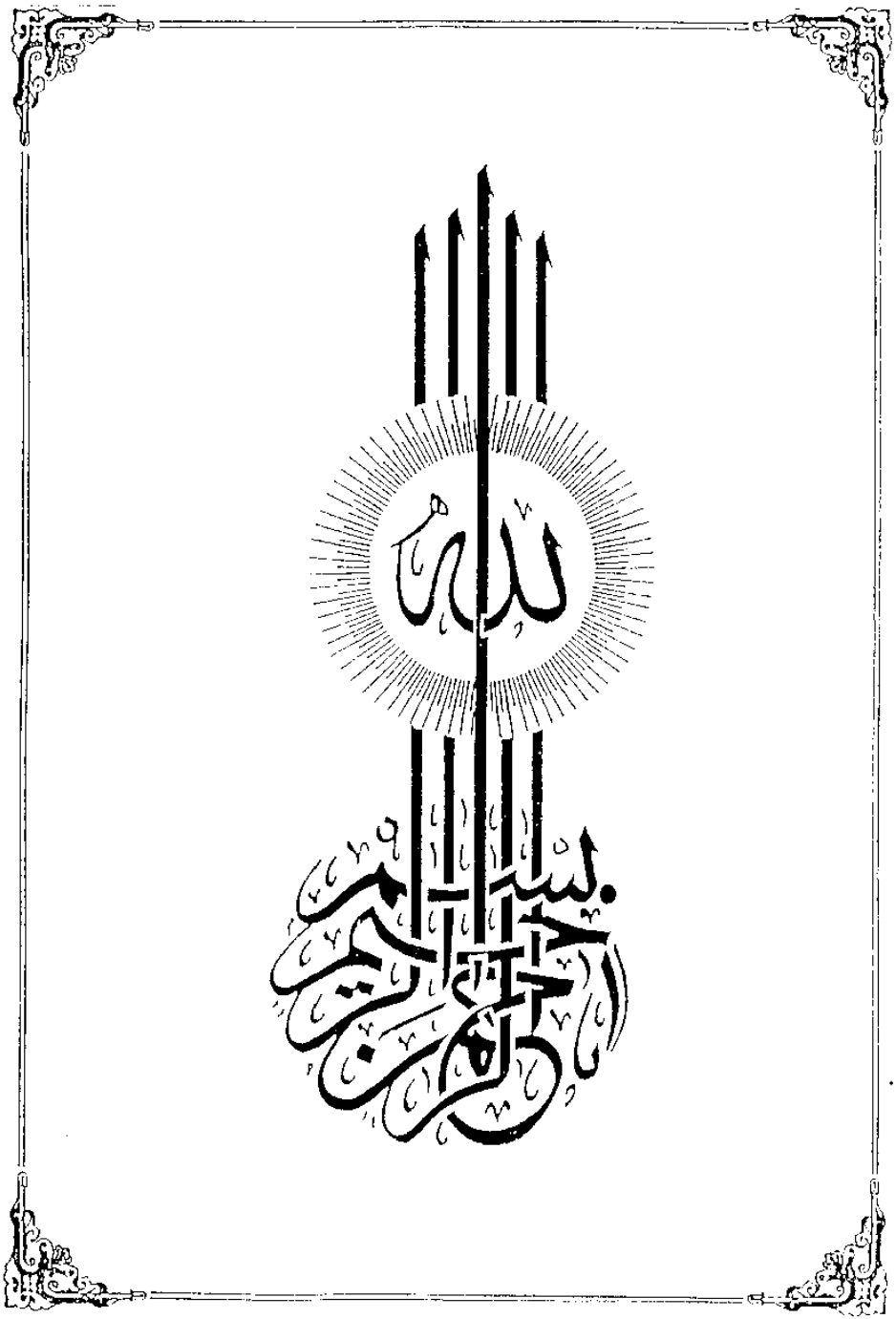

C O N T E N T S

A B S T R A C T

The level structures of ^{76}Se and ^{110}Cd following the beta decay of ^{76}As and ^{110m}Ag respectively have been studied using a Ge(Li), hyper pure Ge spectrometers and a fast-slow coincidence spectrometer (NaI(T ℓ)-H P Ge). Gamma ray energies and relative intensities are given. In ^{76}Se, some recently reported weak γ -transitions are confirmed, besides seven previously unreported γ -transitions of energies 114.8, 141.4, 241.0, 339.8, 586.2, 1046.8 and 1240.4 keV are identified and fitted in the proposed level scheme. The previously reported energy levels at 1881.1, 2025.9, 2079.9, 2123.5, 2169.1, 2183.2, 2346.4, 2362.7 and 2515.4 keV have been confirmed. The energy levels at 2088.4, 2541.0, 1113.92, 1779.76, 2443.70, 2454.50, 2059 and 2866 keV previously reported could not be confirmed.

In ^{110}Cd, fourteen γ -transitions of energies 57.3, 87.9, 144.3, 182.7, 216.7, 232.2, 241.02, 274.1, 310.7, 337.1, 379.26, 455.00, 487.2 and 497.3 keV have been identified for the first time and fitted in the proposed level structure of ^{110}Cd. The previously reported energy levels at 1732.80, 2250.5, 2433.20, 2539.60, 2660.0, 2705.5, 2707.3, 2793.4 and 2876.7 keV have been confirmed. The energy levels

at 1473.33, 2078.8, 2079.0, 2287.4, 2331.8, 2662.4 and 2842.3 keV have been discarded from the level structure of ^{110}Cd. From the directional angular correlation measurements of ^{110}Cd using a $\gamma - \gamma$ fast coincidence system, the 2433.2, 2793.4 and 2876.7 keV levels have been assigned spin values 4 , 4 amd 5 respectively. Previously these levels have been reported as (3, 4), (4,5) and (5,6) respectively. The spin 4 has been confirmed for the 2561.2 keV level. The mixing ratio of nine γ -transitions have been estimated for the first time.

S U M M A R Y

This thesis is concerned with the investigation of Nuclear structure of ^{110}Cd and ^{76}Se nuclei. This has been carried out by investigating the gamma ray enengies and relative intensities in the decay of $^{110m}Ag \longrightarrow {}^{110}Cd$ and $^{76}As \longrightarrow {}^{76}Se$ using Ge(Li) and Hyper pure Ge spectrometers. Besides the different cascades relationships were confirmed and studied through γ - γ coincidence experiments using a NaI(T ℓ) and Ge(Li) fast - slow coincidence spectrometer. Angular correlation measurements have been performed on cascades in ^{110}Cd. Through this study the spin of some levels of ^{110}Cd and the mixing ratio of many γ -rays following the beta decay of $^{110m}Ag \longrightarrow {}^{110}Cd$ have been determined using a NaI (T ℓ) and Hyper pure Ge fast coincidence spectrometer.

The thesis consists mainly of four chapters.

Chapter (I):

This chapter includes a brief introduction about the types of the γ -ray detectors used in the present investigation. Also a survey of the previous investigations of previous works on both ^{110}Cd and ^{76}Se is included.

Chapter (II):

Chapter II is concerned with discussing some basic principles concerning such as: The gamma selection rules, Gamma transition probabilities, the principles of γ - γ coincidence studies and a brief theory of γ - γ directional angular correlation.

Chapter (III)

This chapter contians a general description of the equipment used in the γ - singles spectrometer, the γ- γ fast - slow coincidence spectrometer and the γ - γ fast coincidence spectrometer used in the directional angular correlation measurements.

Chapter (IV):

Chapter four is concerned with the results obtained from the present work concerning:

1- The gamma - singles spectra, the γ - γ coincidences spectra and the level structure of ^{76}Se nucleus.

2- The γ - singles spectra, γ - γ coincidence spectra and the level structure of ^{110}Cd nucleus.

3- The γ - γ directional angular correlation for different cascades in ^{110}Cd and a general cover up of energy levels of ^{110}Cd.

The results of the present investigation can be summarized as follow:

A) The decay of $^{76}As \longrightarrow {}^{76}Se$

(1) In the present singles study of ^{76}Se:

Seven new γ - transitions have been identified for the first time, these are γ - lines of energies 114.8, 141.4, 241.0, 339.8, 586.2, 1046.8 and 1240.4 keV.

The γ -transitions of energies 486.5, 641.4, 755.0, 776.5, 852.3, 863.8, 1060.9, 1098.3, 1393.1, 1466.8 and 1881.1 keV previously reported have been confirmed in the present γ -singles investigation.

The E_γ's = 857.0, 955.0, 1029.0, 2126 and 2670.46 keV previously reported could not be identified in the present singles study.

(2) In the present γ - γ coincidence measurements;

The new gamma transitions of energies 241.0, 339.8, 586.2, 1046.8 and 1240.4 keV have been confirmed in the present γ - γ coincidence measurements.

The 403.3, 465.3, 486.5, 641.4, 665.0, 796.7, 852.3, 863.8, 907.4, 957.6, 1060.9, 1098.3, 1130.3 and 1466.8 keV previously reported have been confirmed in the present γ - γ coincidence measurements.

(3) The new gamma-transitions of energies 141.4 , 1046.8, and 1240.4 keV which have been identified for the first time in the present work and the γ -transitions of energies 403.3, 465.3, 486.5, 665.0, 852.3, 863.8, 907.4, 957.6, 1060.9, 1130.3 and 1564.4 keV which have been confirmed in the present work confirm the existance of the 1881.1, 2025.9, 2079.9, 2123.5, 2169.1, 2183.2, 2346.4, 2362.7 and 2515.4 keV levels.

The 2374.0 keV level previously reported in the ^{76}Se level structure following the Ec decay of ^{76}Br has been supported through the presence of two new γ -transitions of energies 141.4 and 586.2 keV.

The energy levels at 2088.4, 2541.0, 1113.92, 1779.76, 2443.70, 2454.50, 2059 and 2866 keV previously reported before could not be confirmed in the present work.

B) <u>The $^{110m}Ag \longrightarrow {}^{110}Cd$ radioactive decay</u>:

1- Fourteen γ -transitions of energies 57.3, 87.9, 144.3, 182.7, 216.7, 232.2, 241.02, 274.1 , 310.7, 337.1, 379.26, 455.00, 487.2 and 497.3 keV have identified for the first time in the present work.

2- The new gamma transitions of energies 87.9, 144.3, 182.7, 216.7, 232.2, 274.10, 310.7, 337.1, 455.0 , 487.2 and 497.30 keV confirm the existance of the 1732.80, 2250.50, 2433.20, 2539.60, 2660.0, 2705.5, 2707.3, 2793.4 and 2876.7 keV energy levels, which have been previously reported.

3- The 295.56, 603.04, 628.50, 815.58, 1186.64, 1299.88, 1629.65 and 1674.3 keV gamma transitions previously reported could not be detected in the present work consequently the 1473.33, 2078.8, 2079.0, 2287.4, 2331.8, 2662.4 and 2842.3 keV energy levels have been discarded from the level structure of ^{110}Cd.

4- Some recently reported weak γ -transitions of energies 409.5, 436.56, 573.4, 630.7, 708.08 and 1075.05 were confirmed, while the gamma - transitions of energies 67.5, 120.0 and 260.2 keV previously reported could not be identified in the present work.

5- Gamma-Gamma directional angular correlation have been performed for twenty γ - γ cascades in ^{110}Cd nucleus, these are:
(884.67/657.75) keV, (818.01/657.75) keV (1125.69/ 657.75) keV, (677.58/884.67) keV, (937.48/884.67) keV (620.28/884.67) keV, (1384.28/884.67) keV, (997.18/ 884.67) keV, (1018.78/ 884.67) keV, (1117.58/884.67)keV,

(706.7/677.58) keV, (573.40/677.58) keV, (764.0/686.94) keV, (630.7/686.94) keV, (744.24/818.01) keV, (686.94/818.01) keV, (957.44/818.01) keV, (1085.44/818.01) keV, (396.8/937.48) keV and (446.8/937.48) keV.

From this study of γ - γ directional angular correlations in ^{110}Cd one can conclude that:

a) The spins of the 1475.76, 1542.42, 1783.44, 2162.7, 2220.0, 2479.9, 2539.60, 2660.0 and 2926.7 keV levels have been assigned as 2, 4, 2 ,3, 4, 6 , 5, 5 and 5 respectively.

b) The 2433.2 keV level has been assigned spin value 4 previously it has been reported as (3,4).

c) The spin 4 has been confirmed for the 2561.2 keV level.

d) The 2793.4 keV level has been assigned a spin 4 while previously it has been reported as (4,5).

e) The 2876.7 keV level has been assigned a spin 5 while previously it is reported as (5, 6).

f) From the present measurements the mixing ratios of twenty γ-transitions have been measured.